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INTEGRATED MISSION PLANNING

BY

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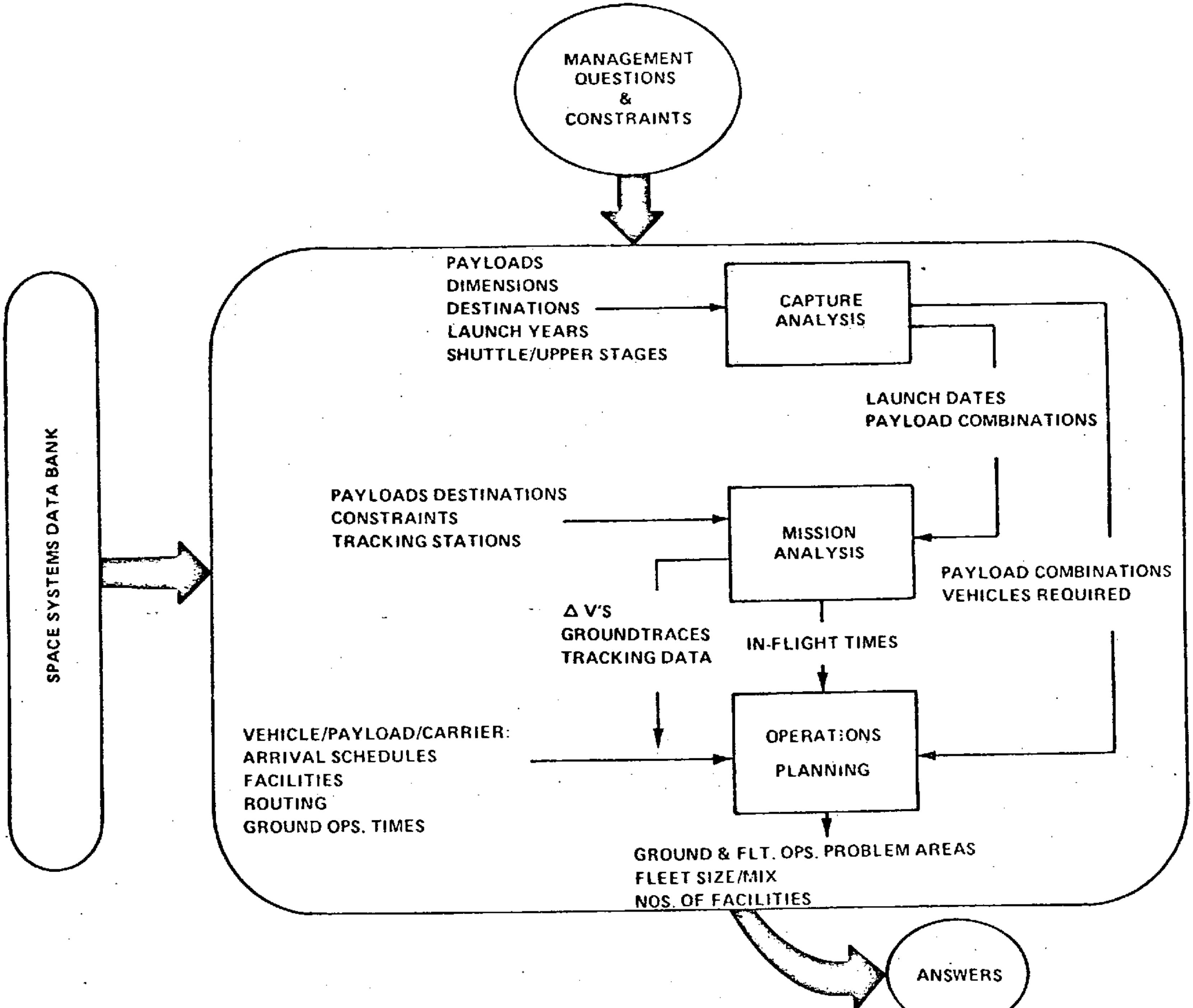
INTEGRATED MISSION PLANNING

Effective advanced program planning requires a thorough understanding of each of the program elements and the impact to the total program of variation in the individual elements. Program Development of MSFC has implemented a systematic approach of mission/system analysis to aid the agency in the planning and development of a viable space program using the Space Shuttle and Space Tug as a transportation system. This approach consists of a three-phase analysis in which the level of detail is consistent with the expected usage of the results.


MANAGEMENT QUESTIONS & CONSTRAINTS
SPACE SYSTEMS DATA BANK
PAYLOADS
DIMENSIONS
DESTINATIONS
LAUNCH YEARS
SHUTTLE/UPPER STAGES
CAPTURE ANALYSIS
LAUNCH DATES
PAYLOAD COMBINATIONS
PAYLOADS DESTINATIONS
CONSTRAINTS
TRACKING STATIONS
MISSION ANALYSIS
PAYLOAD COMBINATIONS
VEHICLES REQUIRED
Δ V'S
GROUNDTRACES
TRACKING DATA
IN-FLIGHT TIMES
VEHICLE/PAYLOAD/CARRIER:
ARRIVAL SCHEDULES
FACILITIES
ROUTING
GROUND OPS. TIMES
OPERATIONS PLANNING
GROUND & FLT. OPS. PROBLEM AREAS
FLEET SIZE/MIX
NOS. OF FACILITIES
ANSWERS

FILE NO. 324

CAPTURE/COST ANALYSIS

INTEGRATED MISSION PLANNING

The first phase of the analysis takes a broad look at a proposed total program. The characteristics of the various elements of the program are modeled according to payload weight, dimensions, destination, launch capability, etc., for use in a computerized analysis. A grouping algorithm is used to determine the packaging of multiple payloads going to a common destination based on constraints input to the program. This computerized approach is used to define a program based on the "Best Mix" of reusable and expendable payloads using cost, launch vehicle capability and availability, refurbishment requirements, turn-around time, etc., as constraints. This level of analysis does not include operational compatibility of the multiple payloads and does not serve to establish specific design requirements.

CAPTURE ANALYSIS FOR EACH PAYLOAD TYPE (CE, CR, LCE, LCR)

↓

COST ASSESSMENT (PAYLOAD + TRANSPORTATION)

↓

PAYLOAD DESIGN SELECTION

↓

RECAPTURE PAYLOADS

↓

BEST MIX

CE	CURRENT EXPENDABLE
CR	CURRENT REUSABLE
LCE	LOW COST EXPENDABLE
LCR	LOW COST REUSABLE

TUG PREFERENCE ORDER

CASE 1	CASE 2, 3, & 4
BIIA	TUG
AGENA	TUG/KICK STAGE
CENTAUR	EXP. TUG
CENTAUR/BII	ORBITAL DOCKING

CASE 5

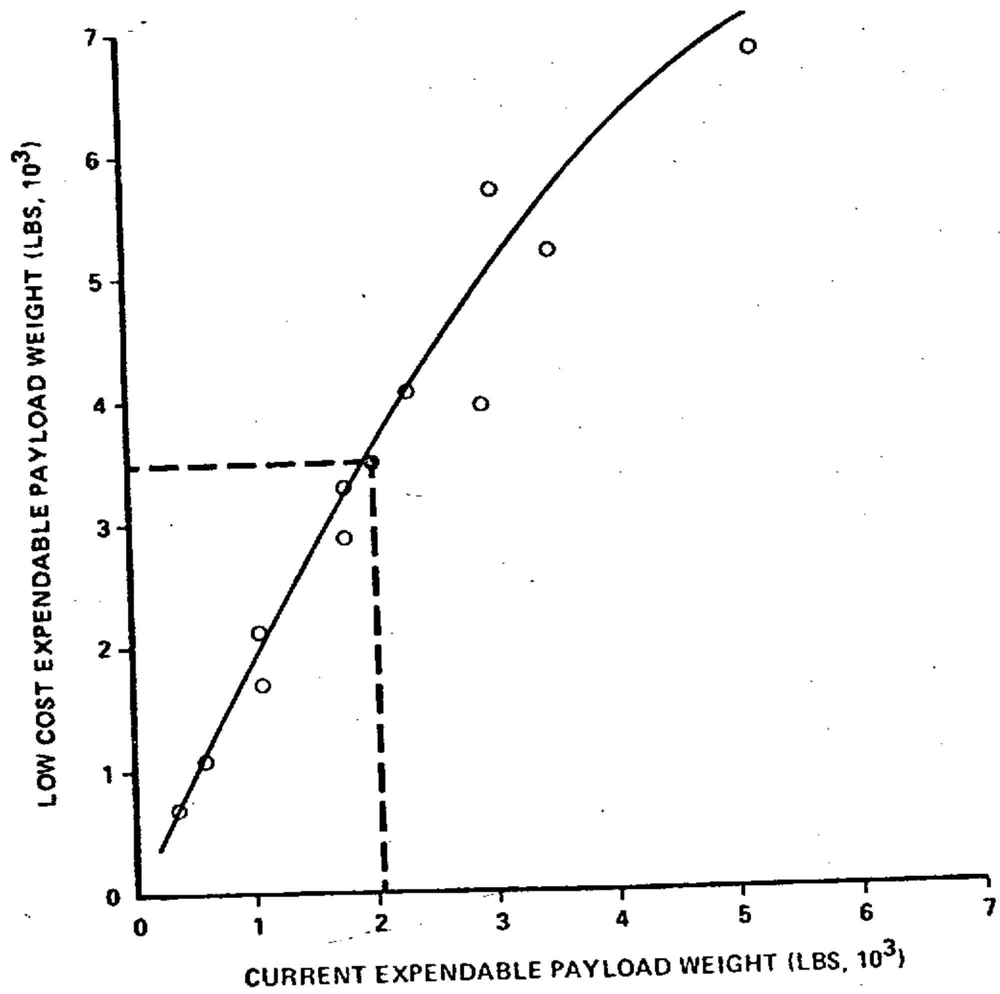
REUSE CORE
REUSE (CORE + TANK)
REUSE CORE + EXP. TANK
REUSE CORE + KS
REUSE (CORE + TANK) + KS
REUSE CORE + EXP. TANK + KS
EXP. (CORE + TANK)
EXP. (CORE + TANK) + KS

INTEGRATED MISSION PLANNING

This chart indicates how the payload designer by taking advantage of the Shuttle's increased volume and weight carrying capability can strive for lower payload costs. Resizing relationships have been developed at the subsystems level jointly by MSFC and LMSC and are utilized in the generation of the "Best Mix" capture analysis.

ORGANIZATION	MARSHALL SPACE FLIGHT CENTER	NAME
PROGRAM DEVELOPMENT PD-DO-PF	INTEGRATED MISSION PLANNING	BILL GOLDSBY
		DATE SEPT. 1973

CE VS LCE PAYLOAD WEIGHT COMPARISON

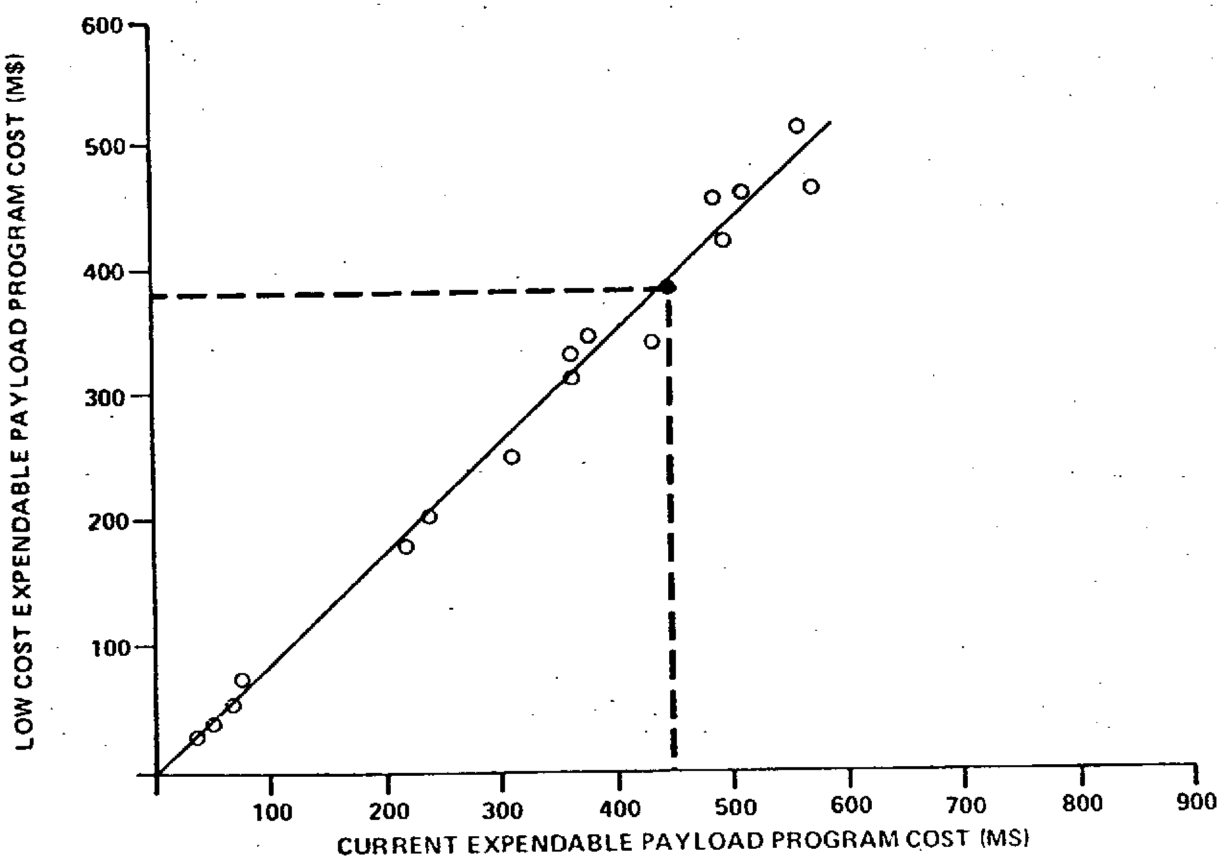


FILE NO 4035

INTEGRATED MISSION PLANNING

This chart displays typical payload program costs savings resulting from the application of low cost design factors. These reductions in payload costs must then be assessed against increased transportation costs (due to weight and volume increases) to establish the minimum total program costs.

CE VS LCE PAYLOAD PROGRAM COST COMPARISON



INTEGRATED MISSION PLANNING

The capture analysis process results in flight schedules for NASA, non-NASA, and DOD from each launch site for the total payload model. It displays the number of Shuttle and upper stages (this example for expendable upper stage flights only) with consideration of factors such as Shuttle build-up rate and launch site availability.

ORGANIZATION	MARSHALL SPACE FLIGHT CENTER	NAME
PROGRAM DEVELOPMENT PD-DO-PF	INTEGRATED MISSION PLANNING	BILL GOLDSBY DATE SEPT. 1973

• EXPENDABLE UPPER STAGES (B-IIA, AGENA, CENTAUR, CENTAUR/B-II)

PROGRAM	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	TOTAL
NASA & NON-NASA													
SHUTTLE FLIGHTS													
ETR	2	11	10	13	14	14	16	18	10	16	15	15	154
WTR	0	0	2	1	2	2	1	2	3	3	3	4	23
TOTAL	2	11	12	14	16	16	17	20	13	19	18	19	177
UPPER STAGE FLIGHTS													
ETR	2	9	8	12	12	13	14	15	7	14	12	14	132
WTR	0	0	3	1	2	2	1	3	3	3	3	4	25
TOTAL	2	9	11	13	14	15	15	18	10	17	15	18	157
DOD													
SHUTTLE FLIGHTS													
ETR	0	2	2	9	12	6	7	9	9	7	12	5	80
WTR	0	0	0	7	3	6	5	4	5	6	3	7	46
TOTAL	0	2	2	16	15	12	12	13	14	13	15	12	126
UPPER STAGE FLIGHTS													
ETR	0	2	2	12	13	6	10	10	9	10	13	6	93
WTR	0	0	0	3	0	2	1	1	1	2	0	4	14
TOTAL	0	2	2	15	13	8	11	11	10	12	13	10	107
TOTAL													
SHUTTLE FLIGHTS	2	13	14	30	31	28	29	33	27	32	33	31	303
UPPER STAGE FLIGHTS	2	11	13	28	27	23	26	29	20	29	28	28	264

FILE NO 3533

INTEGRATED MISSION PLANNING

The capture analysis process also accounts for the number and type of Shuttles and upper stages required for the different users. It indicates the payload type (design philosophy) that results from the "Best Mix" capture analysis.

The technique provides insight into the utilization of transportation elements for the total mission model. Although the capture/cost analysis technique was originally utilized to merely compare the economics of various modes of space transportation, it is very rapidly becoming a tool for making design decisions (upper stage selection, on-orbit servicing vs. payload retrieval, etc.) in the context of total program impacts.

ORGANIZATION	MARSHALL SPACE FLIGHT CENTER	NAME
PROGRAM DEVELOPMENT PD-DO-PF	INTEGRATED MISSION PLANNING	BILL GOLDSBY DATE SEPT. 1973

CASE 1: EXPENDABLE UPPER STAGES

TRAFFIC SUMMARY (1980-1991)

	SHUTTLE FLIGHTS	BII-A FLIGHTS	AGENA FLIGHTS	CENTAUR FLIGHTS	CENTAUR/BII FLIGHTS	SUM OF LIQUID UPPER STAGES FLIGHTS	SUM OF ALL UPPER STAGES FLIGHTS
NASA/NON-NASA	177	23	44	86	4	134	157
DOD	126	21	58	28	–	86	107
TOTAL	303	44	102	114	4	220	264

PAYLOAD TYPE SUMMARY

	CURRENT EXPENDABLE	LOW COST EXPENDABLE	TOTAL 1980-1991
NASA/NON-NASA	14	197	211
DOD	89	80	169
TOTAL	103	277	380

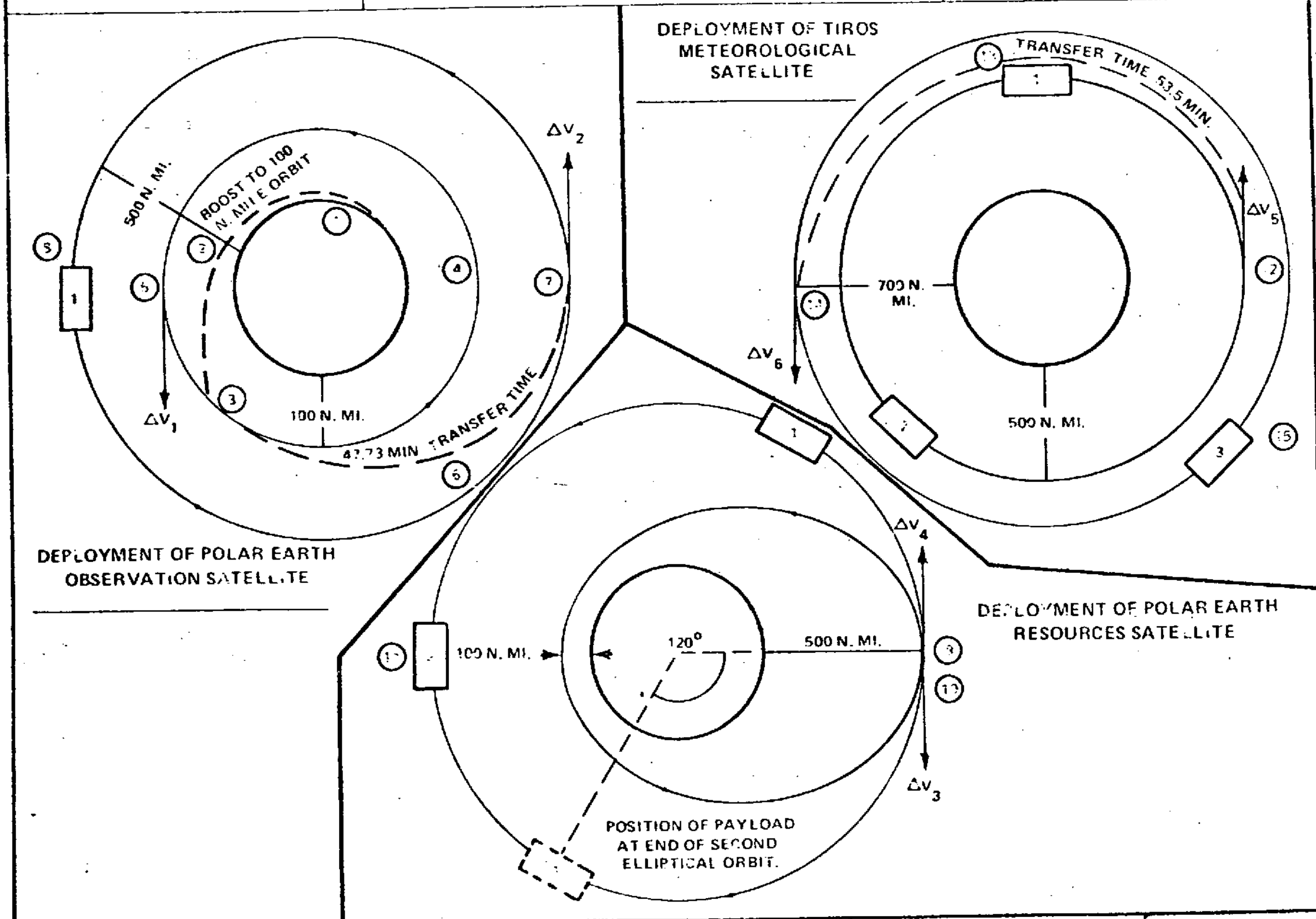
MISSION ANALYSIS

INTEGRATED MISSION PLANNING

In the second phase of the analysis, the physical, functional and operational requirements of the various systems are examined. Flight operations capabilities of the transportation systems are verified against the payload requirements, mission operational analyses are conducted to determine lighting, tracking, ground coverage, orbit lifetime, and other operational constraints of the payloads.

Detailed orbital mechanics trades are made to verify that the results of the packing in the capture analysis is valid and that phasing considerations for deployment and retrieval are satisfied.

ORGANIZATION	MARSHALL SPACE FLIGHT CENTER	NAME
PROGRAM DEVELOPMENT	DEPLOYMENT OF POLAR EARTH OBSERVATION SATELLITE, POLAR EARTH RESOURCE SATELLITE AND TIROS METEOROLOGICAL SATELLITE	BILL GOLDSBY DATE SEPT. 1973



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INTEGRATED MISSION PLANNING

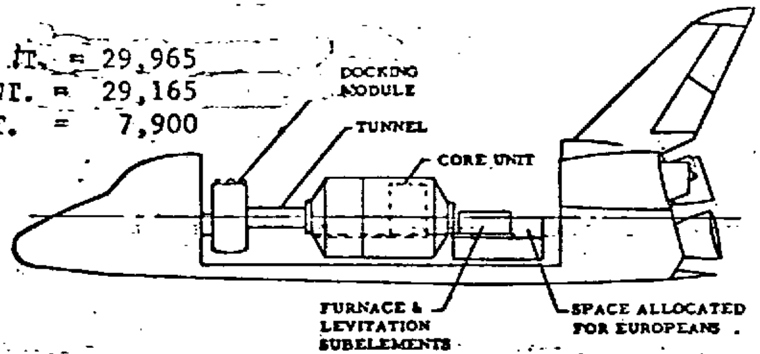
In sortie missions, a time phasing of the experiments are evaluated to minimize support services from the carrier vehicle. A systems analysis is then carried out to establish physical and functional interfaces between the payload elements and the carrier vehicles. This phase of analysis establishes design drivers for both the carrier vehicle and the payloads. Where incompatibilities between carrier vehicle capabilities and payload requirements are determined, trade studies are made to determine the best way to achieve compatibility.

An example is the reconfiguration of many of the sortie flights in the mission model to adhere to the recent down weight and c.g. constraints of the shuttle orbiter.

The mission/interface analysis provides a necessary iteration back to the cost and capture analysis for engineering validity.

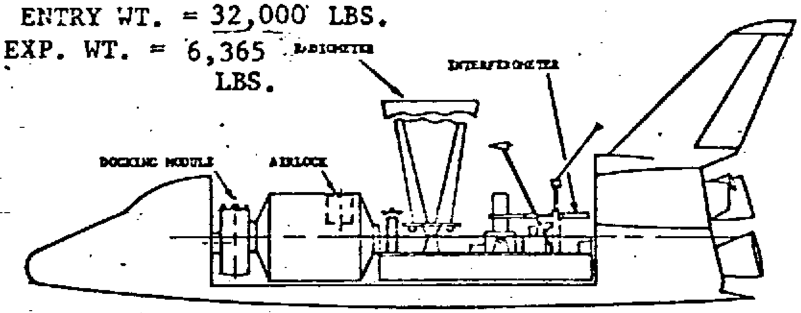
ORGANIZATION:	MARSHALL SPACE FLIGHT CENTER	NAME:
PD-DO-SI	SHUTTLE UTILIZATION	Mordan
	INTEGRATED MISSION PLANNING AND ANALYSIS	DATE: June 1973

LAUNCH WT. = 29,965
ENTRY WT. = 29,165
EXP. WT. = 7,900



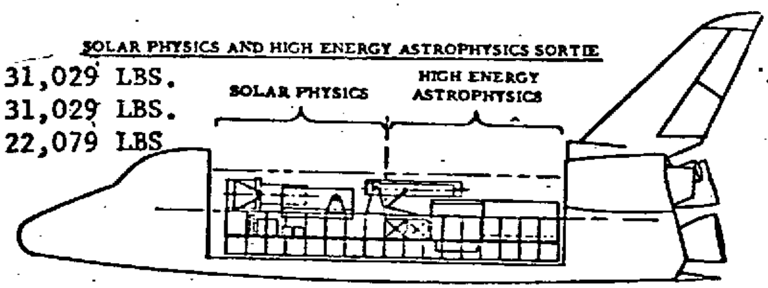
MISSION 8: SPACE PROCESSING APPLICATIONS

LAUNCH WT. = 32,800 LBS.
ENTRY WT. = 32,000 LBS.
EXP. WT. = 6,365 LBS.



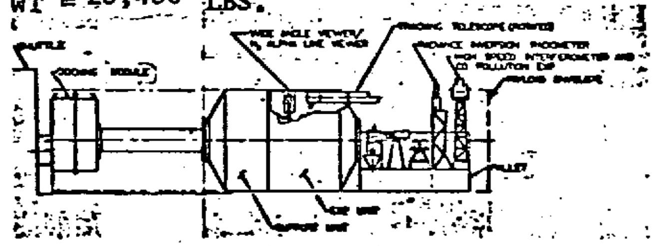
MISSION 17: ADVANCED TECHNOLOGY LABORATORY

LNH WT = 31,029 LBS.
ENT.WT = 31,029 LBS.
EXP WT = 22,079 LBS



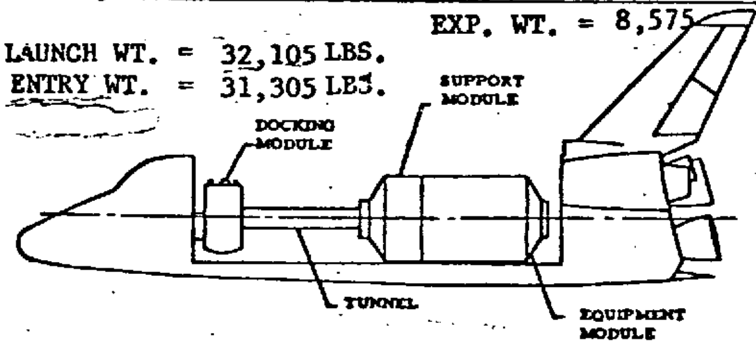
MISSION 13: SOLAR PHYSICS; HIGH ENERGY ASTROPHYSICS

LNH WT = 29,286 LBS. EXP. WT. = 7,221
EXT WT = 28,486 LBS.



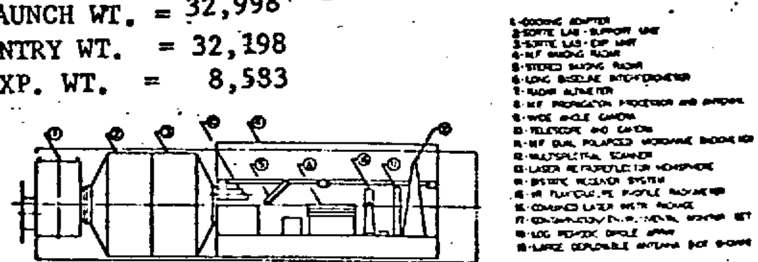
MISSION 15: EARTH OBSERVATIONS

EXP. WT. = 8,575
LAUNCH WT. = 32,105 LBS.
ENTRY WT. = 31,305 LBS.



MISSION 12: LIFE SCIENCES

LAUNCH WT. = 32,998
ENTRY WT. = 32,198
EXP. WT. = 8,583



MISSION 20: EARTH & OCEAN PHYSICS; COMMUNICATION/NAVIGATION

FILE NO.

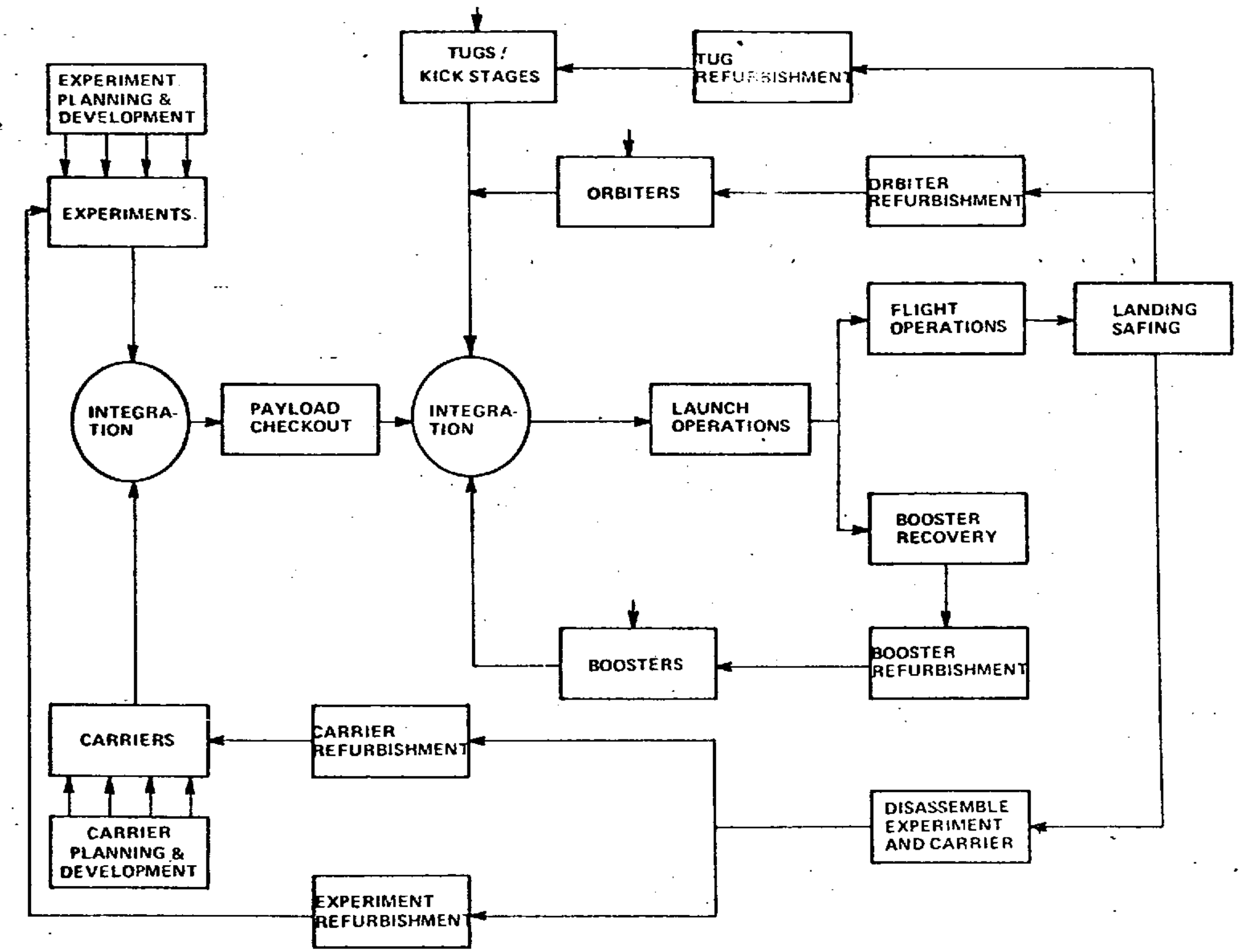
OPERATIONS PLANNING

INTEGRATED MISSION PLANNING

The third phase of analysis is to determine the detailed operational support requirements for carrying out the proposed program. Timelines are developed for the numerous operations and critical paths established. Facility and logistic requirements as well as carrier vehicle fleet size requirements are established for carrying out the proposed program.

Each of the above analysis phases can be carried out as an entity or in parallel with the other phases, however, to realize the potential effectiveness, the outputs of each phase must be used as input and constraints to the other phases.

MARSHALL SPACE FLIGHT CENTER PROGRAM DEVELOPMENT	INTEGRATED MISSION PLANNING	NAME: BILL GOLDSBY DATE: SEPT. 1973

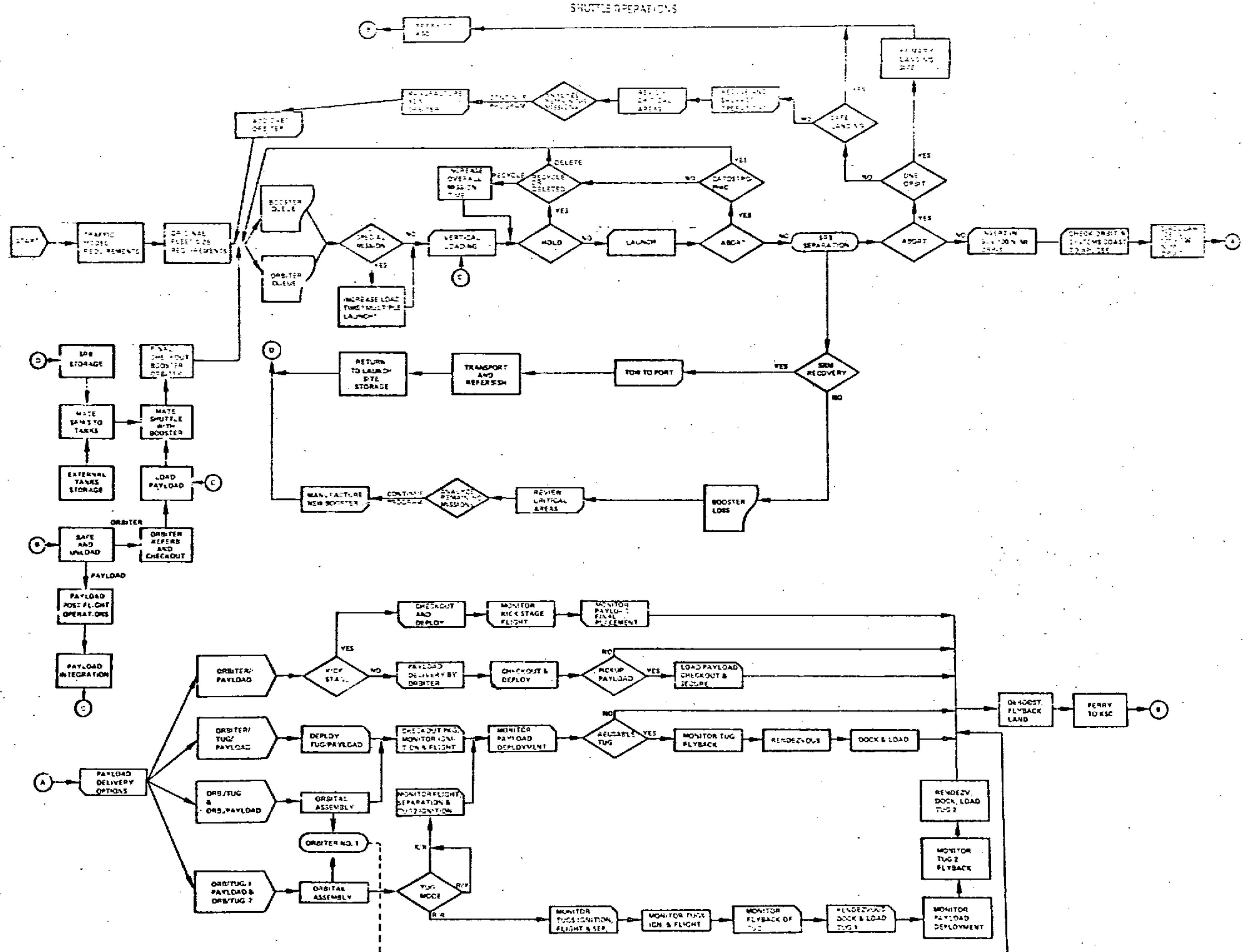


MSFC - Form 3304 (July 1969)

INTEGRATED MISSION PLANNING

The total operational flow (as is presently established) has been simulated utilizing Operations Research techniques to analyze various aspects of the payload activity. This simulation identifies bottle-necks, number of hardware elements required, sensitivity factors, etc.

The computerized simulation runs very rapidly and can be modified very easily (via GPSS) which enhances trade study flexibility.


START
BOOSTER QUEUE
ORBITER QUEUE
VERTICAL LOADING
HOLD
LAUNCH
ABORT
SRB SEPARATION
INCREASE LOAD TIME/MULTIPLE LAUNCH
INCREASE OVERALL MISSION TIME
RECYCLE
DELETE
YES
NO
SRB STORAGE
FINAL CHECKOUT BOOSTER ORBITER
MATE SRMS TO TANKS
MATE SHUTTLE WITH BOOSTER
EXTERNAL TANKS STORAGE
LOAD PAYLOAD
ORBITER
SAFE AND UNLOAD
ORBITER REFERB AND CHECKOUT
PAYLOAD
PAYLOAD POST FLIGHT OPERATIONS
PAYLOAD INTEGRATION
RETURN TO LAUNCH SITE STORAGE
TRANSPORT AND REFERBISH
TOW TO PORT
SRM RECOVERY
MANUFACTURE NEW BOOSTER
CONTINUE PROGRAM
ANALYZE REMAINING MISSION
REVIEW CRITICAL AREAS
BOOSTER LOSS
CHECKOUT AND DEPLOY
MONITOR KICK STAGE FLIGHT
MONITOR PAYLOAD FINAL PLACEMENT
ORBITER/PAYLOAD
KICK STAGE
PAYLOAD DELIVERY BY ORBITER
CHECKOUT & DEPLOY
PICKUP PAYLOAD
LOAD PAYLOAD CHECKOUT & SECURE
DEORBIT, FLYBACK LAND
FERRY TO KSC
ORBITER/TUG/PAYLOAD
DEPLOY TUG/PAYLOAD
CHECKOUT PKG, MONITOR IGNITION & FLIGHT
MONITOR PAYLOAD DEPLOYMENT
REUSABLE TUG
MONITOR TUG FLYBACK
RENDEZVOUS
DOCK & LOAD
PAYLOAD DELIVERY OPTIONS
ORB/TUG & ORB/PAYLOAD
ORBITAL ASSEMBLY
MONITOR FLIGHT, SEPARATION & DETONATION
ORBITER NO. 1
RENDEZV. DOCK, LOAD TUG 2
MONITOR TUG 2 FLYBACK
ORB/TUG 1 PAYLOAD & ORB/TUG 2
TUG MODE
MONITOR TUGS IGNITION, FLIGHT & SEP.
MONITOR TUGS IGN. & FLIGHT
MONITOR FLYBACK OF TUG
RENDEZVOUS DOCK & LOAD TUG 1
MONITOR PAYLOAD DEPLOYMENT

INTEGRATED MISSION PLANNING

An example of the utilization of the simulation is the generation of the sortie hardware (modularized concept) requirements to satisfy the 1973 Mission Model. This simulation was a function of the flight requirements (resulting from the capture analysis), the processing times (integration of experiments, refurbishment, checkout, etc.), and wear-out rates for each element.

This same type of simulation can provide insight into number of orbiters, SRB, Tugs, etc., required to satisfy the flight schedule generated in the capture analysis.

ORGANIZATION PROGRAM DEVELOPMENT PD-DO-P	MARSHALL SPACE FLIGHT CENTER INTEGRATED MISSION PLANNING	NAME BILL GOLDSBY DATE SEPT. 1973

PRELIMINARY RESULTS FROM OPERATIONS PLANNING SIMULATION (OPS) REQUIRED SORTIE HARDWARE ELEMENTS

TYPE ELEMENT / NO. REQ'D	FORWARD BULKHEADS	SUPPORT MODULES	EXP. MODULES	AIRLOCK MODULES	AFT BULKHEADS	OVERLAPS	5' SEGMENTS	10' SEGMENTS
ACTIVE UNITS	4	4	2	3	11	8	14	40
REPLACEMENTS * FOR WEAROUT	N/A	2(4)	1(2)	0	N/A	N/A	N/A	N/A
TOTAL	4	6(8)	3(4)	3	11	8	14	40

SORTIE HARDWARE ELEMENTS TO SATISFY NASA AND NON-NASA MISSIONS

TYPE ELEMENT / NO. REQ'D	FORWARD BULKHEADS	SUPPORT MODULES	EXP. MODULES	AIRLOCK MODULES	AFT BULKHEADS	OVERLAPS	5' SEGMENTS	10' SEGMENTS
ACTIVE UNITS	4	4	2	4	11	8	18	40
REPLACEMENT * FOR WEAROUT	N/A	3(4)	1(2)	0	N/A	N/A	N/A	N/A
TOTAL	4	7(8)	3(4)	4	11	8	18	40

*BASED ON LIFETIME OF 350 DAYS ON - ORBIT; ASSUMES ALL ELEMENTS FOR 12- YEAR PROGRAM ACQUIRED AT BEGINNING OF PROGRAM SO THAT WEAR IS DISTRIBUTED EVENLY ON ALL UNITS.

(   ) ASSUMES REPLACEMENT UNITS ACQUIRED AT TIME ORIGINAL ELEMENTS WEAR OUT.

FILE NO.

INTEGRATED MISSION PLANNING

The overall integrated mission planning activity thru an iterative process is necessary to guarantee that the payload objectives and requirements are compatible with the Shuttle system and the planned operational capability.

ORGANIZATION	MARSHALL SPACE FLIGHT CENTER	NAME
PROGRAM DEVELOPMENT	INTEGRATED MISSION PLANNING	BILL GOLDSBY
		DATE SEPT. 1973